Brownian Duet: A Novel Tale of Thermodynamic Efficiency

Christian Van den Broeck

Stellenbosch Institute for Advanced Study, STIAS, Mostertsdrift, Matieland 7602, South Africa
and
Hasselt University, B-3590 Diepenbeek, Belgium

Thermodynamic machines come in many different guises: thermal and iso-thermal engines, operating periodically or in steady state, of macroscopic or microscopic scale. The efficiency and response properties of these machines have to be in agreement with the second law of thermodynamics and of its generalisation – the so-called fluctuation theorem, see, e.g., [1] – in case of a small system. We introduce a new exactly solvable model, namely a Brownian particle subjected to a duo of periodic forces, that illustrates all the connections [2]. The results are reproduced experimentally, including the experimental verification of some recent predictions concerning efficiency [3] and stochastic efficiency [4].

[1] C. Van den Broeck and M. Esposito, "Ensemble and trajectory thermodynamics: A brief introduction", Physica A **418**, 6 (2014).

[2] K. Proesmans, Y. Dreher, M. Gavrilov, J. Bechhoefer, and C. Van den Broeck, "Brownian duet: A novel tale of thermodynamic efficiency", Phys. Rev. X **6**, 041010 (2016).

[3] K. Proesmans, B. Cleuren, and C. Van den Broeck, "Power-efficiency-dissipation relations in linear thermodynamics", Phys. Rev. Lett. **116**, 220601 (2016).

[4] G. Verley, T. Willaert, C. Van den Broeck, and M. Esposito, "The unlikely Carnot efficiency", Nat. Comm. **5** (2014).